	DEPART	MENT OF STA	CLASS: I M.Sc. Statistics					
Sem	Course Type	Course Code	Course Title	Credits	Contact Hours/week	CIA	Ext	Total
Ι	Major Core – 1	21P1SMC1	Real Analysis and Linear Algebra	4	5	25	75	100

Nature of Course							
Knowledge and skill	<		Employability oriented				
Skill oriented			Entrepreneurship oriented				

Course Objectives:

The main objectives of this course are to:

1. Expose the students to get knowledge on real analysis and linear algebra.

2. Grasp the concepts of convergence of sequence and series of real numbers.

3. Develop the ability of proving theorems and solving the problems in real analysis and linear algebra.

Unit	Description	Hours	K-Level	CLO(s)
1	Introduction to n-dimensional Euclidean space and metric space – Countability, supremum and infimum of sets of real numbers – Bolzano-Weirstrass theorem. Convergence of sequences and series of real numbers – absolute and conditional convergence – Point-wise and uniform convergence – Tests for absolute, conditional and uniform convergence – Properties of uniform convergence.	18	K2	1
2	Real valued functions - Limits and continuity and uniform continuity – Differentiability – Maxima and Minima of functions – mean value theorem, Taylor's theorem – functions of several variables.	13	К3	2
3	Riemann-Stieltjes sums – Riemann-Stieltjes integral – Properties and Evaluation – Fundamental theorem – Differentiation under integral sign – Leibnitz's rule - Improper integrals - Multiple integrals and their evaluation by repeated integration.	15	К3	3
4	Vector Space - sub-space, basis of vector space – Gram- Schmidt orthogonalization. Linear transformation (LT) and its properties – matrix of linear transformation – matrix of inverse transformation – change of basis, orthogonal transformation, dual space.	13	K4	4
5	Linear equations – Generalized inverse of a matrix. Eigenvalues and eigenvectors of a LT –Diagonalizable LT, Cayley-Hamilton theorem and minimum polynomial for a LT – Eigenvalues of matrix polynomials. Quadratic forms and their classifications- Sylvester's law of inertia – reduction involving the eigen-values of the matrix.	16	K4	5

Books for Reference:

- 1. Malik, S.C., and Arora, S, (2009), Mathematical Analysis, Second Edition, New Age International, New Delhi.
- 2. Arora, S, (1988), Real Analysis, SatyaPrakashanMandir, New Delhi.
- 3. Rudin, W. (2016), Principles of Mathematical Analysis, Fourteenth reprints McGraw-Hill, New Delhi.
- 4. Kenneth Hoffman and Ray Kanze 2nd Edition (1971) Linear Algebra PHI publisher, New Jersey
- 5. Goldberg, R.R. (1976) Methods of Real Analysis, Oxford & IBH, New Delhi.
- 6. Apostol, T.M. (1997) Mathematical Analysis, Narosa, New Delhi.
- 7. Somasundaram, D. (2002) Mathematical Analysis, Narosa, New Delhi.
- 8. Datta, K.E. (1991) Matrix and Linear Algebra, Prentice-Hall, New Delhi.
- 9. Rao, C.R. (1973) Linear Statistical Inference and its Applications, Wiley Eastern, New Delhi.
- 10. Searle, S.R. (1973) Linear Models, Wiley, New York.
- 11. Ramachandra Rao, A. and Bhimasankaran, P.(1992) LinearAlgebra, Tata McGraw Hill, New Delhi.
- 12. Ajit Kumar and Kumaresan, S, (2014), A Basic Course in Real Analysis, Chapman and Hall/CRC Press.

Web references:

- 1. Euclidean space and metric space: https://www.math.uci.edu/~gpatrick/source/205b06/chapviii.pdf
- 2. Mean value theorem <u>https://byjus.com/jee/mean-value-theorem/</u> <u>https://www.youtube.com/watch?v=xYOrYLq3fE0</u>
- 3. Taylors theorem <u>https://www.youtube.com/watch?v=LEspaisjDFE</u>
- 4. Riemann-Stieltjes integral https://www.youtube.com/watch?v=TpKIeWgcmC8
- 5. Vector space https://www.youtube.com/watch?v=1XIT3Y2oyAU
- 6. Linear transformation and matrix https://amsi.org.au/ESA Senior Years/SeniorTopic8/8a/8a 2content 3.html
- 7. Linear algebra https://www.commonlounge.com/discussion/efdfcf2937b94fbeb7a3e1a309381d85

Rationale for Nature of the course

This course will enable the students to comprehend the theoretical and applied concepts of Real analysis and Linear Algebra which enables to apply for the statistical concepts.

Pedagogy:

Chalk and Talk, PPT, Assignments, Seminar, Problem solving.

Lecture Schedule

Unit	Topics	Hours	Mode		
	Introduction to n-dimensional Euclidean space and metric space	2			
	Countability, supremum and infimum of sets of real numbers	3	Chalk and Talk,		
	Bolzano-Weirstrass theorem	2	PPT,		
Ι	Convergence of sequences and series of real numbers	3	problem solving		
	absolute and conditional convergence	2	and Assignments		
	Point-wise and uniform convergence	2	-		
	Tests for absolute, conditional and uniform convergence	3			
	Properties of uniform convergence	1			
	Real valued functions - Limits and continuity and uniform continuity	3			
	Differentiability – Maxima and Minima of functions	2	Chalk and Talk,		
II	Mean value theorem	3	PPT,		
	Taylor's theorem	2	problem solving		
	Functions of several variables	3	and Assignments		
	Riemann-Stieltjes sums	2			
	Riemann-Stieltjes integral	2			
	Properties and Evaluation	1	Chalk and Talk		
тт	Fundamental theorem	2			
111	Differentiation under integral sign	2	problem solving		
	Leibnitz's rule	2	Assignments and Seminar		
	Improper integrals	2			
	Multiple integrals and their evaluation by repeated integration	2			
	Vector Space - sub-space, basis of vector space	2	Challs and Talls		
	Gram-Schmidt orthogonalization	2	DDT		
IV	Linear transformation and its properties	2	problem solving		
1.4	Matrix of linear transformation	3	Assignments and		
	Matrix of inverse transformation	2	Seminar		
	Change of basis, orthogonal transformation, dual space	2			
	Linear equations – Generalized inverse of a matrix	2			
	Eigenvalues and eigenvectors of a linear transformations	2			
	Diagonalizable linear transformations	2	Chalk and Talk		
v	Cayley-Hamilton theorem and minimum polynomial for a linear transformations	3	PPT,		
	Eigenvalues of matrix polynomials	2	problem solving,		
	Quadratic forms and their classifications	2	Assignments and Seminar		
	Sylvester's law of inertia	2			
	Reduction involving the eigen-values of the matrix	1			

Course Learning Outcomes

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CLO's	Course Learning Outcomes	Knowledge Level
CLO-1	Understand the meaning of converges in sequences and series of real	Up to K2
CLO-2	Identify the given functions are continuous or discontinuous.	Up to K3
CLO-3	Understand the conditions for integrability of real valued functions.	Up to K3
CLO-4	Describe the fundament concepts of vector and linear transformations.	Up to K4
CLO-5	Determine the characteristic roots, eigen vector, the nature and reduction of quadratic forms.	Up to K4

On the successful completion of the course, students will be able to

MAPPING CLOs WITH PSOs

#	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CLO-1	2	3	2	1		2	2
CLO-2	2	2	2	2	1	2	1
CLO-3	3	1	2	1		2	1
CLO-4	2	2	1		1		1
CLO-5	2	3	2		2	3	2

Advance application -3; Intermediate level -2; Basic level -1

		Section – A Short Answer		Sect	ion B	Section C	
	K-Level			Either /	' Or type	Open Choice	
		No. of Questions	K Level	No. of Questions	K Level	No. of Questions	K level
CLO 1	Up to K2	2	K1, K1	2	K2, K2	1	K2
CLO 2	Up to K3	3	K2, K2, K3	2	K3 , K3	2	K3, K3
No. of questions to be asked		5		4		3	
No. of question to be answer		5		2		2	
Marks for each question			2	:	5	10	
Total marks for each section			10	1	0	20	

CIA-I–BluePrint

K Levels	Section A (No choice)	Section B (Either/ or)	Section C (Open choice)	Total marks	% of marks without choice	Consolidated	
K1	4	-	-	4	6.67	46.67%	
K2	4	10	10	24	40		
K3	2	10	20	32	53.33	53.33%	
K4	-	-	-	-	-	-	
Total marks	10	20	30	60	100	100	

CIA-I: Distribution of section wise marks with K-levels

CIA-II Blue Print

		Sect	ion – A	Sectio	on B	Section C		
	K-Level	Short	Answer	Either / Or type Op		Open Cl	en Choice	
CLO S		No. of Questions	K Level	No. of Questions	K Level	No. of Questions	K level	
CLO 3	Up to K3	2	K1, K1	2	K2, K3	2	K2, K3	
CLO 4	Up to K4	3	K2, K2, K3	2	K3, K4	1	K4	
No. of questions to be asked		5		4		3		
No. of question to be answer			5	2		2		
Marks for each question			2	5		10		
Total marks for each section			10	10)	20		

CIA-II: Distribution of section wise marks with K-levels

K Levels Section A (No choice)		Section B (Either/ or)	Section C (Open choice)	Total marks	% of marks without choice	Consolidated
K1	4	-	-	4	6.67	38 33%
K2	4	5	10	19	31.66	30.3370
K3	2	10	10	22	36.67	36.67%
K4	-	5	10	15	25.00	25.00%
Total marks	10	20	30	60	100	100

ts			SectionA SectionB		SectionC	SectionD		
j n			MCQs		ShortAnswers		(Either/or	(OpenChoice)
-	CLOs	K- Level	No.of	K. Level	No.of	K-	Choice)	(openenoice)
			Question	K-Level	Questions	Level		
1	CLO1	Up to K2	2	K1& K1	1	K1	2(K1&K1)	1(K2)
2	CLO2	Up to K3	2	K2& K3	1	K1	2(K3&K3)	1(K3)
3	CLO3	Up to K3	2	K2& K3	1	K2	2(K2&K2)	1(K3)
4	CLO4	Up to K4	2	K3& K4	1	K2	2(K4&K4)	1(K4)
5	CLO5	Up to K4	2	K3& K4	1	K3	2(K4&K4)	1(K4)
No	. of Que	estions	10		5		10	5
to l	be asked	l		10	5		10	5
No	.of Ques	stions to		10	5		5	3
be	answere	d	10		5		5	5
Marks for each question			1	2		5	10	
Total Marks for		10		10	10		30	
eac	h sectio	n		10		,	23	50

Summative Examination -Blue Print

Distribution of Marks with K Level for Summative Examination

K - Level	Section A (MCQ)	Section B (Short Answer Questions)	Section C (Either / Or Choice)	Section D (Open Chioce)	Total Marks	% of (Marks without Choice)	Consolidated
K1	2	4	10	-	16	13.33	35%
K2	2	4	10	10	26	21.67	5570
K3	4	2	10	20	36	30.00	30%
K4	2	-	20	20	42	35.00	35%
K5	-	-		-			
Total	10	10	50	50	120	100	100

Course Designers:

- 1. Dr. R MADHANAGOPAL
- 2. Dr. M. VENKATESWARAN